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ALLELOPATHIC EFFECTS OF *ARGEMONE MEXICANA* AQUEOUS EXTRACT ON *VIGNA MUNGO* DEVELOPMENT

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ABSTRACT:

The current investigation aimed to ascertain how *Argemone mexicana* L. affected *Vigna Mungo* protein content, photosynthetic pigments, seed germination, and seedling growth in an allelopathic manner. The most significant edible crop is the black gram. Though it may grow in various soil types and temperatures, black gram is most successful in humid areas with 30-90 cm of precipitation. *Argemone mexicana* L. is a marijuana cultivator that is increasing and is a significant competitor to the black gram in terms of allelochemicals. One of the main factors reducing crop productivity is weeds. After harvesting and washing them with tap water to remove dirt particles, the complete *Argemone mexicana* L. plant was dried in the shade and maintained at 25°C (±2) for 72 hours. To illustrate the germination of locally cultivated Black gram seeds, four concentrations of varying ratios of aqueous extract were prepared. A bioassay experiment evaluated *Argemone mexicana* L. allelopathic capacity on Black gram seed germination. Weed extracts diluted with water were employed as a therapy. A pronounced inhibitory action of *Argemone mexicana* L. was noted on Black gram.

Keywords: Allelochemicals, *Argemone Mexicana*, Aqueous extract, Photosynthetic pigments, Weeds

1. INTRODUCTION

In general, non-native species that can undermine or negatively impact local flora and fauna are considered invasive foreign species (Drake et al., 2003). Habitat degradation is the top danger to biodiversity worldwide, followed closely by invasive alien species (Rajasekaran et al., 2020) The worldwide integrity of natural and agricultural ecosystems is at risk due to invasive alien plant species that displace native species and form mono-species in recently discovered areas. The worldwide integrity of natural and agricultural ecosystems is at risk due to invasive alien plant species that displace native species and form mono-species in recently discovered areas (Callaway & Aschehoug, 2000; Seastedt et al., 2008). Several theories explain how invader species can compete with native species. These consist of their liberation from inborn adversaries, which helps them stay in check and reach their maximum competitive potential (Callaway & Aschehoug, 2000; Maron et al., 2004); the development of enhanced competitiveness; phenotypic plasticity (Stockwell et al., 2003; Blossey & Notzold, 1995). This facilitates the manufacturing of allelopathic chemicals, which in turn helps invasive plants adapt to new settings and compete with native plants in recipient communities (Yuan et al., 2013).

Most invasive plant species exhibit defensive and competitive traits, which explain the allelopathic effect (Callaway & Ridenour, 2004). Allelochemicals also have an impact on native species through a variety of mechanisms, such as inhibition of protein synthesis (Li et al., 2010), alteration or inactivation of specific hormone and enzyme activity and functions (Cruz-Ortega et al., 2007), disruption of plant nutrient intake, elongation in roots and shoots, and interference with cell division (Chen et al., 2002), alteration of membrane permeability (Weir et al., 2004), and interference with the production of chlorophyll (Muzaffar et al., 2012). Worldwide livelihoods are at risk due to invasive species' degradation of the environment, decrease in biodiversity, and alteration of ecological processes (Vitousek, 1990). In ecology, there has long been discussion on the mechanisms behind effective plant invasion (Losapio et al., 2019). According to the "new weapon hypothesis" (NWH), For plant invaders to be successful, they must be able to bring novel phytochemicals into the invaded community. (Callaway & Maron, 2006). According to the NWH, the success of invasive species is mostly dependent on plant biochemical weapons including allelopathic and antibacterial root exudates, which directly obstruct the growth of native plants.

Allelopathy is a plant species' ability to produce chemicals that can impact nearby plants or soil microbes. It has long been known that this ability is a crucial functional characteristic that can modify the behavior of nearby plants and, eventually, the structure of plant communities. Anti-plant allelopathic compounds have the ability to directly affect adjacent plant tissues, preventing the growth and germination of seedlings or adult plants (Zhang et al., 2020). Allelopathy is the biological phenomenon whereby an organism creates biochemical compounds that affect the morphology and physiology of another organism. Various processes transport chemicals from one plant to another, including volatilization, leaching, root exudation, and leaf particle deposition (Jali et al., 2021).

Allelochemicals may inhibit the growth of shoots and roots or stop cell division. Allelochemicals such as phenolic compounds shorten the length of the root and shoot. Allelochemicals likely impede plant growth by disrupting their growth pathways. Allelochemicals released may harm a plant's ability to absorb nutrients and grow shoots and roots or disrupt the natural symbiotic interaction between a plant and its food source. Allelopathic symptoms are all caused by the presence of one or more allelochemicals. The specific allelochemicals involved and their properties have a significant role in determining the effectiveness of allelopathy (Samal et al., 2024).

The potential allelopathy of *Argemone mexicana*
An explanation of *Argemone mexicana*
The Papaveraceae family includes the annual weed *Argemone mexicana* (AM) native to Mexico. Dry climates and agriculture are its leading associations. It is an essential weed for many crops in the world's humid temperate, tropical, and subtropical regions. This plant is known by several colloquial names, such as Cardo/Cardosanto, Mexican prickly poppy, and flowering thistle. Agara, Bharband, Bharbhar, Brahamadandi, Kantakusama, Peela Kanteela, and other names are among the various that this plant is known by in India.
Taxonomic classification:
Phylum: Spermatophyta
Class: Dicotyledonae
Order: Papaverales
Family: Papaveraceae
Genus: Argemone
Species: *Argemone mexicana* L.


Figure 1. *Argemone mexicana*

Medicinal value
The oil and sap of seeds have been identified as having medicinal properties. According to ethnobotany, the complete plant is combined to treat asthma. The sap from the sliced ends of the stem can be used to treat toothaches. Children who urinate indiscernibly are given petal mixes (Defilipps et al., 2004; Mandal et al., 2020). It is a homeopathic preparation in Madhya Pradesh, India (Oudhia et al., 1998). The plant's leaves are used as cosmetics in African countries. To increase the potency of the seeds, they are pulverized and combined with tea or beer (Rukangira, 2001). To make the seeds of this plant more potent, little amounts of mustard oil is added in India.; however, combining more than that small number of seeds with mustard is considered adulteration.

Effects of this weed
A. mexicana is a weed in most cropping systems, and perennial harvests like sugar cane and coffee. Any crop grown in the habitat range of this plant will probably include *A. mexicana* contamination.

Economic Impact
This plant is a significant weed of vegetables, cereals, cotton, timber, millets, and fiber-producing plants. Still, it is also considered a potent contaminant of grazing animals and poultry. Aflatoxin production by the species is deadly and toxic to herbivorous animals;

afflicted cattle's milk, eggs, and mutton-based products are also contaminated (Alemayehu & Desalegn, 2016).

Environmental Impact

Allelochemicals produced by the plant are known to impact neighboring plants in native environments, their ability to photosynthesize pigments, the germination of seeds, and their ongoing growth (Namkeleja et al., 2014).

Social Impact

A.mexicana has a significant negative influence on the health of humans in India and neighboring countries as dealers purposefully blend this weed with safe-to-eat vegetable oil or accidentally contaminate it. This weed has been identified as a solid northern and central India allergen (Sharma et al., 2002).

Allelopathic effect of some Exotic invasive plants

With roots in the Americas, the invasive plant species *Lantana camara* severely threatens forest resources and ecosystems since it overruns pastures, woodlands, tea plantations, and even orchards. They are also dangerous weeds because of their toxicity. If consumed recklessly, they pose a risk of poisoning to both humans and animals. Recent research has shown that Lantana camara's severe allelopathy might impede the growth of nearby plants (Priyanka, N., & Joshi, P. K., 2013).

In southern China, *Ageratum conyzoides* L. is one of the most problematic weeds. According to a recent study, phenolic chemicals taken from the leftover leaves trigger the allelopathy. (Kaur et al., 2012).

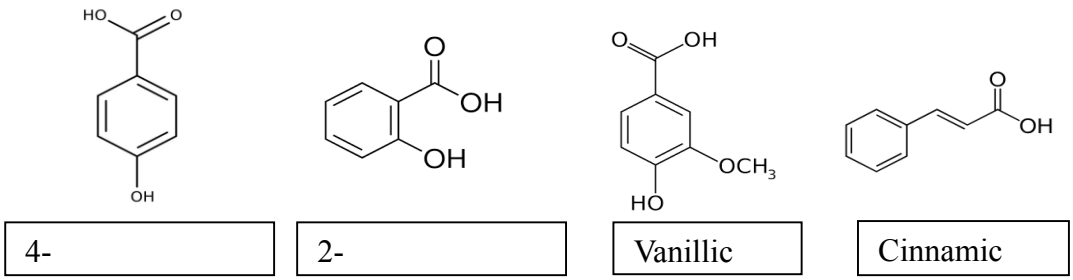
Parthenin, a sesquiterpene lactone produced from pseudoguanolides, is most concentrated in the leaves of the ragweed plant, *Parthenium hysterophorus* L. The entire plant contains parthenin. Kanchan (1975). Green Amaranthus (*Amaranthus viridis* L.), coffee senna (*Cassia occidentalis* L.), barnyard grass (*Bromus tectorum*), and small-seeded canary grass (*Phalaris minor* Retz) all had decreased height and dry weight following pre- and post-emergent parthenin treatment. (Batish et al., 2007).

Common lantana (*Lantana camara* L.) contains allelochemicals in a range of forms, such as leaves, stems, roots, fruits, and flowers (Weir, 2004). Numerous allelochemicals are present in common lantana, such as iridoid glycosides, flavonoids, furanonaphoquinones, triterpenes, diterpenes, monoterpenes, and sesquiterpenes (Sharma et al., 2002). Lantadene A and B are the two most potent allelochemicals in common lantana.

Allelochemicals present in *Argemone mexicana*

Receptor plant germination, growth, development, and establishment are influenced by allelochemicals emitted by donor plants, facilitating plant interaction. These processes largely determine vegetation patterns. Allelochemicals produced by invasive plants can give them a competitive advantage by directly or indirectly suppressing the growth of native species that compete with them in natural settings. Phenolic substances, such as vanillic acid, cinnamic acid, 2-hydroxybenzoic acid, and 4-hydroxybenzoic acid, are the primary allelochemicals of *A. mexicana* (Burhan & Shaukat, 1999). One of the plants' most common secondary metabolites is phenolic chemicals, which play an essential role in plant metabolism and defense against pathogen aggression or UV radiation (Muzaffar et al., 2012). Natural and managed ecosystems have been shown to include phenolic allelochemicals, which can lead to ecological and commercial issues such as crop output declines from soil sickness, natural forest regeneration failures, and replanting in orchards (Li et al., 2010).

Figure 2. Allelochemicals present in *Argemone mexicana*



4-Hydroxybenzoic Acid (p-Hydroxybenzoic Acid)

Phenolic benzoic acid gives rise to phosphoryl benzoic acid., also known as monohydroxy benzoic acid. It dissolves more readily in polar organic solvents like acetone and alcohol than water or chloroform. Higher plants' benzoic acid derivatives are often linked to allelopathy (Rice, 1984). One way that p-hydroxybenzoic inhibits plant growth is by interfering with the equilibrium between plants and water (Chen et al., 2002) report that p-hydroxybenzoic acid lowers nearby plants' chlorophyll content, photosynthetic rate, and root activity, affecting their physiological features. High quantities of p-hydroxybenzoic acid were found to inhibit soybean improvement, water-related potential, and conductance from stomatal cells. by Barkosky and Einhellig (Barkosky & Einhellig, 2003).

2-Hydroxybenzoic Acid (Salicylic Acid)

The phytohormone salicylic acid (SA) is phenolic. It is a component of transpiration, ion uptake, growth and development, and plant transport. It also modifies explicitly the chloroplasts' structure and the leaves' anatomy (Einhellig et al., 1993; Durner et al., 1997). Salicylic acid is engaged in a variety of plant physiologic processes, such as pathogenesis-related abiotic stress resistance (Yuan & Lin, 2008), which is achieved by stimulating the synthesis of proteins related to pathogenesis (Van Huijsduijnen et al., 1986), including heat shock protein (Clarke et al., 2004) and antioxidant enzymes. It is a Systemic Acquired Resistance (SAR) process component, which occurs when a pathogen attacks one portion of a plant and causes resistance in other sections (Durrant & Dong, 2004). The signal can also reach nearby plants by transforming salicylic acid into the volatile ester methyl salicylate. Salicylic acid, a prominent phenolic component in plants, has been identified as an allelopathic molecule. (Chandra et al., 2007) examined the effects of salicylic acid on four cowpea genotypes (*Vigna unguiculata*) regarding seed germination, seedling growth, flowering, and biochemical activity. They found that there were adverse effects on seedling development and germination. The development of soybean (*Glycine max* L.) seedlings was inhibited by salicylic acid, and the tissue of treated plants displayed a superior stable carbon isotope ratio (13C:12C) in comparison to the control, indicating that salicylic acid caused water stress (Barkosky & Einhellig, 1993). Thus, disruption of the interactions between plants and water is one way this allelochemical prevents plants from growing. Salicylic acid is sometimes used as a stimulant to lessen the negative impact of certain plant species' allelopathic components on other species' germination characteristics.

Vanillic Acid

Vanillic acid's allelopathic potential inhibited soybeans' growth, stomatal conductance, and water potential. Vanillic acid's allelopathic potential in tomatoes was assessed by (Ghareib et al., 2010). The results showed that whereas the highest concentrations of vanillic acid had detrimental impacts on every parameter they evaluated, the lowest amounts promoted the germination and growth of tomatoes and specific antioxidant enzyme activity. (Esmaeili et al., 2012; and Chen et al., 2011) also, vanillic acid inhibited seedlings' growth and germination on aubergine (*Echinochloa crus-galli* L). Certain grasses and legumes that grow well in natural

environments may have their germination and growth prevented by *A. mexicana* due to its vanillic acid content.

Cinnamic Acid

One such phenolic acid that permeates the soil is cinnamic acid (CA), which may be found in the decomposing plant components of many different plants, including lucerne, as well as leaf leachates and root exudates (Yu & Matsui, 1994) and cucumber (Chon et al., 2002). Cinnamic acid is one of the phenolic chemicals that, when given exogenously, has the allelopathic effect of inhibiting germination and growth (Singh et al., 2013). One allelochemical that induces allelopathy in the development of cucumber roots is cinnamic acid. (Ding et al., 2007), as well as in the cabbage seedlings' fresh and dry weight and the length of their shoots and roots. (*Brassica oleracea* var. capitata) (Singh et al., 2013). Cinnamic acid has an allelopathic effect on aubergine seedling growth and verticillium wilt (*V. dahliae*) at high concentrations (Chen et al., 2011). *A. mexicana* also contains cinnamic acid, which may impact neighboring plants' germination and growth.

Bioherbicides in weed control

Scientists have developed bioherbicides, which control weed populations without harming non-target organisms by using live species or their secondary metabolites. Allelochemicals that come from plants will be the only focus of this study. Plant-based allelochemical bioherbicides are gaining popularity to eliminate weed resistance, decrease the need for synthetic herbicides, and mitigate their adverse environmental consequences because of their many advantages. Strong soil biodegradability, chemical stability, and water solubility are some of these characteristics.

2. MATERIAL AND METHODOLOGY

Aqueous Extract Solution Preparation

From various agricultural areas, *A. mexicana* plant seeds and leaves were gathered. The seeds and leaves were set to air dry at room temperature for eight days after being carefully cleaned with distilled water. The seeds and leaves were ground into a powder using a blender. One hundred grams of the ground material was then individually steeped for 72 hours in a corked, one liter of distilled water was placed into a conical flask, and the mixture was filtered using Whatman filter paper No. 1. The extract was diluted to reach the concentrations of 10%, 50%, 100%, and 200%, while distilled water was used as the control treatment.

Figure 3. Sample solutions of different concentrations

Calculating the Radical Length, Root Length, Shoot Length, and Germination Percentage

Following three cycles of running tap water to eliminate impurities, the seeds were surface sterilized with 5% sodium hypochlorite for two minutes. Following that, distilled water was used to rinse them four times. *Vigna mungo* was used to investigate the toxicity of *A—*

Mexicana's aqueous extract. Thirty seeds of each target species were put in a pot. Four sets of treated seeds were created by placing seeds in pots with varying percentages of *Argemone mexicana* extract (10%, 50%, 100%, and 200%), as the control group consisted of seeds that had been treated with distilled water. No refrigeration was applied to the pots. When necessary, extract or distilled water was used to wet the seeds. The seeds were watched daily, and it was counted how many seeds sprouted (germination count). When the radicals were at least 2 mm in length, germination was considered. On the fifteenth day after germination, the lengths of the roots and shoots were measured.

Using the following formula, the germination percentage (GP) was calculated:

GP= [NTx100]/N

For the final measurement, N represents the total number of seeds used in the bioassay, and NT represents the percentage of germination in each treatment.

Figure 4. Germination of *Vigna mungo* in different *Argemone mexicana* plant extract concentrations.

Determination of water content

A computerized weighing balance determined each seedling's fresh and dried weights. A single plant, *Vigna mungo*, including shoots and roots, was used to measure the water content following a 20-day treatment with aqueous extracts of *A. mexicana*. The seedlings' new weights were noted after thoroughly washing them with distilled water and blotting paper to dry them. The samples were baked for two days at 60°C to dry them out, then the dry weights (DW) were calculated.

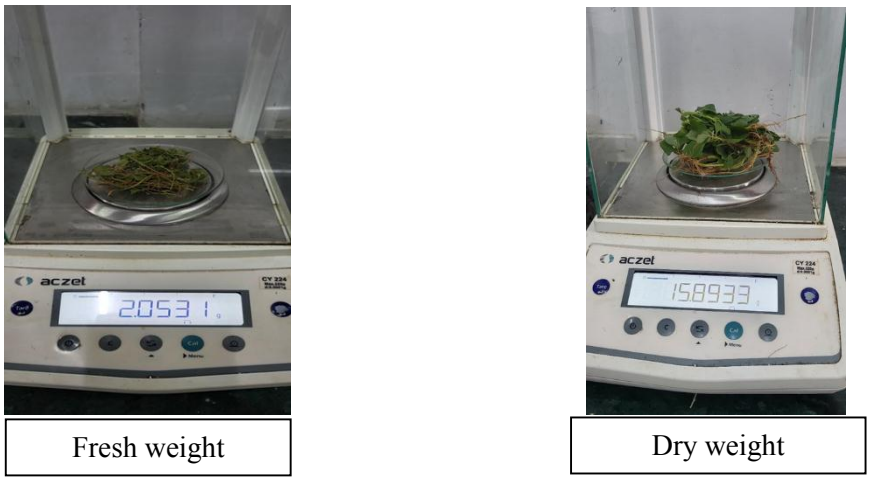


Figure 5. Determination of water content and biomass

Determination of Photosynthetic pigments
Fresh, healthy leaves weighing 500 mg were homogenized in 80% cold acetone. The combined materials underwent a 10-minute dark centrifugation at 4,000 rpm and 4°C. After removing the supernatant, the absorbances were noted.

Determination of Total leaf protein
The acetone-TCA technique was used to extract the soluble proteins. Following extraction, samples underwent centrifugation. for 20 minutes at 14,000 rpm to collect the supernatant. After taking a 0.2 ml sample, 1 ml of deionized water was added. It was left for 10 minutes after an additional 5 ml of alkaline Copper solution was added. After adding 0.5 ml of the Folin-Ciocalteau reagent, leave it for half an hour in the dark. Later on, the absorbance at 660 nm was determined. The soluble proteins were extracted using the acetone-TCA method. The supernatant was collected from the samples by centrifuging them for 20 minutes at 14,000 rpm after extraction. A 0.2 ml sample was taken, and then 1 ml of deionized water was added. It was left for 10 minutes after an additional 5 ml of alkaline Copper solution was added. After adding 0.5 ml of the Folin-Ciocalteau reagent, leave it for half an hour in the dark. Later on, the absorbance at 660 nm was determined.

Determination of phytoconstituent present in *A. mexicana*
After thoroughly washing, the plant materials were allowed to dry in the shade. The material that has been shade-dried is powered, and photochemical analysis is performed on the powder. Subsequently, the powder underwent Soxhlet extraction using varying solvents (methanol and water) based on their increasing polarity. Distinct phytochemical components were examined in the final extract obtained from each solvent. Phytoconstituents were detected qualitatively through phytochemical screening of *A. mexicana* leaf extracts.

Statistical analysis
After three consecutive experiments and five duplicates, the average and standard deviation were obtained. depict the data. The allelopathic effect of *A. mexicana* on *Vigna mungo* was analyzed and compared using ANOVA at a significance level of $p \leq 0.05$.

3. RESULTS AND DISCUSSION

Effect of *A. mexicana* **on Seed germination assay and plant growth of** *Vigna mungo*
Various amounts of aqueous extracts from *A. mexicana* caused multiple reactions in the germination rate of *Vigna mungo* seeds. *Vigna mungo* seeds' germination rates varied depending on the amount of *A. mexicana* aqueous samples (10 mg/ml, 50 mg/ml, 100 mg/ml, and 200 mg/ml). It was discovered to diminish as *A. mexicana* concentration rose, with a more noticeable effect in the 200 mg/ml treatment (Table 1) (Fig 6).
At 83.33% (control), 76.66% (10 mg), 56.66% (50 mg), 40% (100 mg), and 30% (200 mg), the germination percentage was noted. *A. mexicana* aqueous doses caused a decrease in radicle length, accounting for 4.18 cm for 10 mg and 1.50 cm for 200 mg (Table 1) (Fig 7).
Table 1. % of germination and length of radicals of *Vigna mungo*

Sample	Treatments(mg/ml)	Germination (%)	Radical length (cm)
Vigna mungo	Control	83.33 ± 0.72^{a}	4.34 ± 0.18^{a}
	10	76.66 ± 0.87^{b}	4.18 ± 0.18^{a}
	50	56.66 ± 1.56^{b}	3.50 ± 0.19^{b}
	100	40 ± 1.53^{c}	2.82 ± 0.16^{c}
	200	30 ± 0.94^{d}	1.50 ± 0.20^{c}

Note: Based on the DMRT analysis, the values in the table are the mean ± SD of five replicates; letters indicate significant differences between treatments at the 5% level of significance ($P \leq 0.05$).

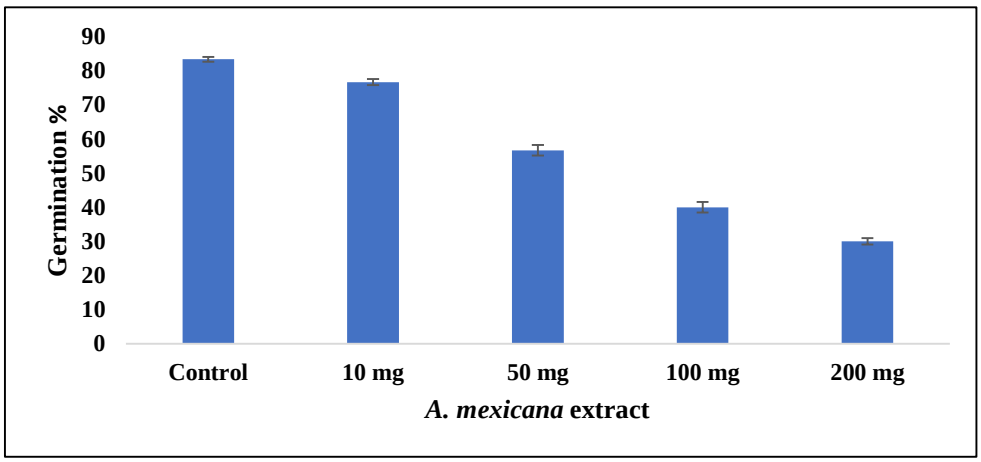


Figure 6. Germination percentage of *Vigna mungo* exposed to various ratios of *A. mexicana* plant extracts.

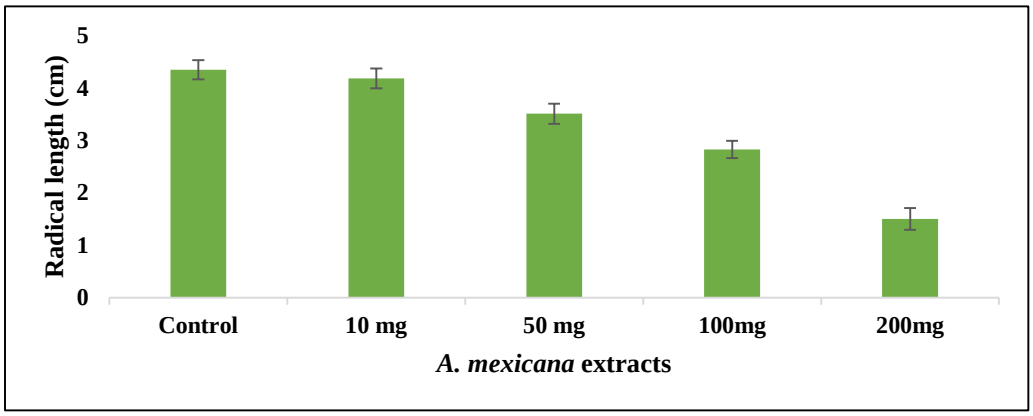


Figure 7. The radical length of *Vigna mungo* was exposed to various ratios of *A. mexicana* plant extracts.

Effect of *A. mexicana* on the growth of *Vigna mungo*

A. mexicana extracts in the nutrient medium showed significant growth reduction of *Vigna mungo*. In comparison to the control (13.34 cm), shoot growth was severely impacted at 200 mg (5.49 cm), 100 mg (6.61 cm), 50 mg (9.38 cm), and 10 mg (12.68 cm) (Fig. 8). All treated samples (root lengths measuring 4.18 cm, 3.42 cm, 2.51 cm, 1.61 cm, and 1.02 cm at control, 10 mg, 50 mg, 100 mg, and 200 mg extracts, respectively) exhibited decreased growth. (Table 2).

It is well-recognized that abiotic stress is highly toxic and negatively affects plant growth (Rubio et al., 1994; Watanabe & Suzuki, 2002; Maksymiec & Krupa, 2006). The growth medium drastically reduced Shoot and root length (Jing et al., 2005).

Table 2. Effect of *A. mexicana* on growth of *Vigna mungo*

Sample	Treatments(mg/ml)	Shoot length (cm)	Root length (cm)
Vigna mungo	Control	13.34 ± 0.26^{a}	4.18 ± 0.09^{a}
	10	12.68 ± 0.18^{b}	3.42 ± 0.21^{b}
	50	9.38 ± 0.31^{b}	2.51 ± 0.15^{c}
	100	6.61 ± 0.28^{c}	1.61 ± 0.08^{c}

	200	5.49 ± 0.30[d]	1.02 ± 0.18[d]

Note: Based on the DMRT analysis, the values in the table are the mean ± SD of five replicates; letters indicate significant differences between treatments at the 5% level of significance (P ≤ 0.05).

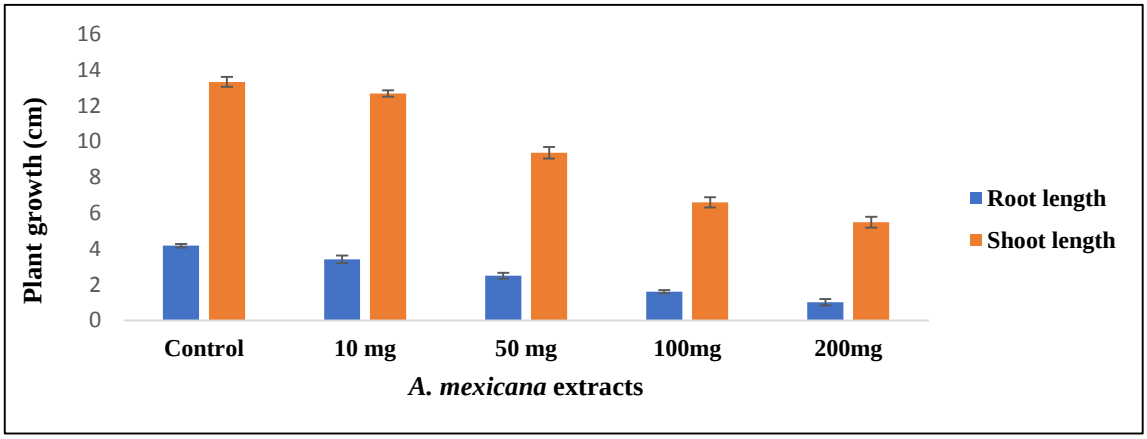


Figure 8. Shoot and Root length of *Vigna mungo* subjected to varying amounts of *A. mexicana* plant-based extracts.

Effect of *A. mexicana* **on the biomass of** *Vigna mungo*

A. mexicana extracts demonstrated a notable decrease in biomass in *Vigna mungo*. *A. mexicana* extracts 10 mg (79.31%), 50 mg (74.35%), 100 mg (55.17%), and 200 mg (50.01%) had a substantial impact on biomass in comparison to the control group (86.36%) (Table 3; Fig. 9). Plant biomass is impacted by growth decrease (Ismail & Mah, 1993; Day et al., 2016). The biomass of *Vigna mungo* was reduced at higher doses of the weed extracts. As the concentrations of aqueous extracts increased, so did the water content.

Table 3. Effect of *A. mexicana* on biomass of *Vigna mungo*

Sample	Treatments (mg/ml)	Fresh weight (gm)	Dry weight (gm)	Water Content (%)
Vigna mungo	Control	0.66 ± 0.04[a]	0..09 ± 0.03[a]	86.36%
	10	0.58 ± 0.07[a]	0.12 ± 0.04[b]	79.31%
	50	0.39 ± 0.03[b]	0.1 ± 0.01[b]	74.35%
	100	0.29 ± 0.03[c]	0.16 ± 0.01[c]	55.17%
	200	0.18 ± 0.03[d]	0.09 ± 0.01[c]	50.01%

Note: Based on the DMRT analysis, the values in the table are the mean ± SD of five replicates; letters indicate significant differences between treatments at the 5% level of significance (P ≤ 0.05).

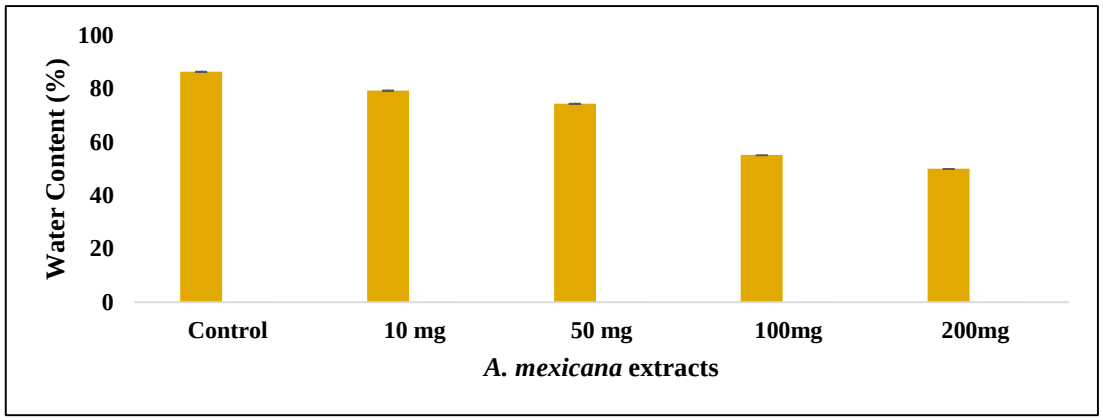


Figure 9. Biomass of *Vigna mungo* exposed to varying ratios of *A. mexicana* plant extracts

Effect on Changes in photosynthetic pigments of *Vigna mungo*

In table 4 summarizes the number of photosynthetic pigments (carotenoids, total chlorophyll, Chl *a*, and Chl *b*) at various concentrations of *A. mexicana*. When *A. mexicana* levels rose, *Vigna mungo*'s carotenoid and chlorophyll levels dropped dramatically compared to control plants (Fig 10). *Vigna mungo* plants' chlorophyll content decreased when exposed to *A. mexicana* extracts, from 10 mg to 200 mg. Chl *a* concentration was measured at 146.21 µg/g and 45.9 µg/g after treatment with aqueous extracts of the *A. mexicana* plant at 10 mg/ml and 200 mg/ml, respectively. *Vigna mungo* plants' chlorophyll-b content decreased when exposed to *A. mexicana* extracts, from 10 mg to 200 mg. After being exposed to 200, 100, 50, and 10 mg/ml extracts of *A. mexicana*, respectively, carotenoids revealed 32.8 µg/g, 40.65 µg/g, 61.26 µg/g, 98.57 µg/g, and 92.77 µg/g.

At different doses, extracts from *A. mexicana* significantly suppress the photosynthetic pigments of *Vigna mungo*. This could be because some chloroplasts were destroyed or the photosynthetic activity was decreased or impeded by the release of secondary metabolites (Cen et al., 2004; Huang et al., 2012; Jyothilakshmi et al., 2015). A decrease in the cellular Mg^{2+} ion concentration, which is necessary for the manufacture of chlorophyll, was found to cause a considerable reduction in the amounts of Chl *a*, Chl *b*, and carotenoid (Yildirim, 2008).

Table 4. Effect of *A. mexicana* on photosynthetic pigments of *Vigna mungo*

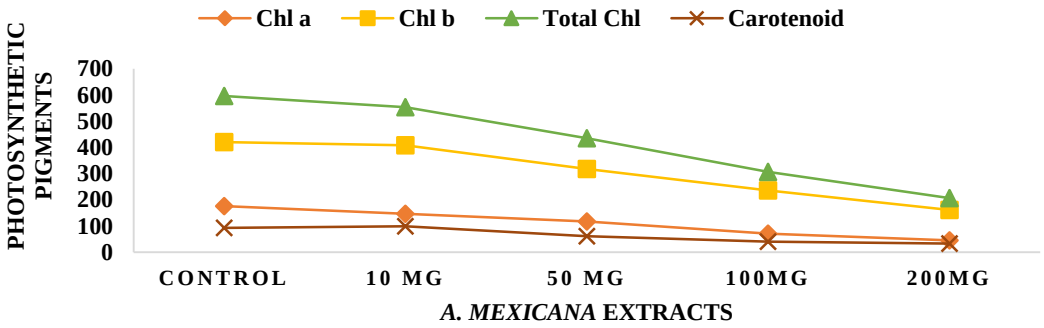
Treatments (mg/ml)	Chl *a*	Chl *b*	Total Chl	Carotenoid
Control	175.42 ± 14.52^{a}	420.55 ± 7.55^{a}	595.97 ± 15.09^{a}	92.77 ± 4.38^{a}
10	146.21 ± 7.09^{a}	407.52 ± 9.71^{b}	553.59 ± 7.65^{b}	98.57 ± 4.85^{b}
50	116.88 ±14.26^{b}	317.50 ± 24.88^{b}	434.38 ± 18.10^{b}	61.26 ± 12.73^{c}
100	71.18 ± 12.74^{c}	235.55 ± 24.69^{c}	306.66 ± 16.27^{b}	40.65 ± 12.05^{c}
200	45.9 ± 10.12^{d}	160.87 ±13.36^{d}	206.77 ±14.42^{d}	32.8 ± 8.97^{d}

Note: Based on the DMRT analysis, the values in the table are the mean ± SD of five replicates; letters indicate significant differences between treatments at the 5% level of significance ($P \leq 0.05$).

Figure 10. Plant extracts from *A. mexicana* were treated to varying photosynthetic pigments in *Vigna mungo*.

Changes in total soluble protein content

Under various *A. mexicana* treated extracts, *Vigna mungo*'s total soluble protein exhibited notable alterations (Table 5; Fig. 11). At 10 mg/ml, 50 mg/ml, 100 mg/ml, and 200 mg/ml, respectively, the soluble protein values of 16.56 mg, 14.37 mg, 12.91 mg, and 09.43 mg were decreased by the *A. mexicana* treatment. According to the findings above, plants under stress exhibit lower protein levels than controls.



The interruption of the translation pathway following exposure to the released allelochemicals may cause a drop in protein levels. Similar observations were obtained with plants under biotic and abiotic stress (Parida et al., 2004; Jali et al., 2019).

Table 5. Total soluble protein content (mg/g fr.wt.) of *Vigna mungo* in response to different concentrations of *A. mexicana* treatment.

Sample	Treatments(mg/ml)	Total soluble protein content (mg/g fr.wt.)
Vigna mungo	Control	18.74 ± 0.23^{a}
	10	16.56 ± 0.17^{b}
	50	14.37 ± 0.21^{b}
	100	12.91 ± 0.15^{c}
	200	09.43 ± 0.13^{d}

Note: Based on the DMRT analysis, the values in the table are the mean ± SD of five replicates; letters indicate significant differences between treatments at the 5% level of significance ($P \leq 0.05$).

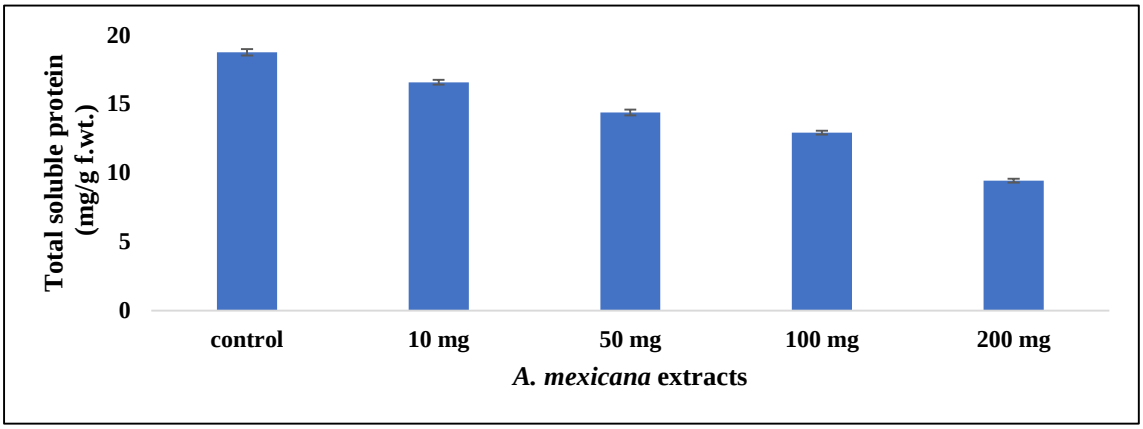


Figure 11. *Vigna mungo* total soluble protein content was exposed to different concentrations of *A. mexicana* plant extracts.

Allelochemicals analysis

Alkaloids, anthraquinones, flavonoids, saponins, and steroids were the most prevalent bioactive components found in the extracts of *A. mexicana* leaves, according to phytochemical screening. (Table 6).

Table 6. Preliminary allelochemicals screening of leave extracts of *A. mexicana*

Phytochemicals present	**Test**	**Aqueous**	**Methanol**
Alkaloids	Wagnor's test	+	+

Anthraquinones	Chloroform layer test	++	+++
Glycosides	Killer-Killani's test	-	-
Flavonoids	1- Shinoda test	+++	+++
Reducing sugars	Fehling's test	-	+
Saponins	honeycomb test	++	-
Steroids	Salkowski test	-	+++
Tannins	ferric chloride test	-	-
Terpenoids	modified Salkowski test	+	-

Note. +++ = remarkably present; ++ = moderately present; + = slightly present; - = absent

4. CONCLUSIONS

When comparing plants exposed to varying amounts of *A. mexicana* extract, the biochemical parameters, plant growth, and *Vigna mungo* seed germination rate all increased under control circumstances. Plants treated with weed extracts showed a discernible decrease in protein content, photosynthetic pigments, shoot and root length, and seed germination. The release of secondary metabolites from *A. mexicana* may have contributed to the decrease in *Vigna mungo* biomolecules observed in this study. The ANOVA showed a significant inhibitory effect of the aqueous weed extracts upon the target plant ($p<0.05$). The weed extracts in this investigation impede the physiology and growth of the crop plant. Soon, this investigation will identify a few phytocompounds or metabolites with advantageous applications for agricultural sustainability. Crop-to-crop sensitivity to allelochemicals and the degree of inhibition vary, but crop protection from several dangerous plant species will improve.

Finally, we conclude that composting *A. mexicana* is a means to minimize its allelopathic inhibition potential and one way of management by utilization. Therefore, resource poor farmers could use the high nutrient contents of *A. mexicana* compost and control weeds by composting.

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